## 3.6 Hydrogen Codes and Standards

The U.S. and most countries in the world have established laws, codes, and regulations that require products and systems being developed meet all applicable codes and standards to demonstrate that they are safe, perform as designed, and are compatible in systems use. Hydrogen is well known as a chemical, but its use as an energy carrier on a large-scale commercial basis is largely untested and undeveloped. To enable the commercialization of hydrogen in consumer products, new model building codes and equipment and other technical standards will need to be developed and recognized by federal, state, and local governments.

Codes and standards have repeatedly been identified as a major institutional barrier to deploying hydrogen technologies and developing a hydrogen economy. The lack of codes and standards for hydrogen technologies is not confined to any one country -- it is a global problem. The aim of this program element is to identify those codes and standards that will be necessary or helpful in the design and implementation of the hydrogen economy, to facilitate the development of such standards, and to support publicly available research and certification investigations that will be necessary to develop a basis for such codes and standards. The development and commercialization of hydrogen energy technologies are of national interest,. DOE can significantly accelerate the identification of current gaps in the standards development process and the evaluation of the adequacy of existing and newly-developed standards, by providing funding to address these issues.

***Building codes and equipment standards establish a basis for technical discussions and provide a systematic and accurate means of measuring and communicating product risk and insurability to the customer, general public, and fire-safety certification officials.***

***Building Codes – An extensive compilation of provisions covering a broad technical subject. Codes are suitable for adoption into law independent of other codes and standards. They incorporate, by reference, various equipment standards***

***Equipment Standards - Technical definitions and guidelines that serve as instructions for designers. Standards are voluntary, and like codes, can be incorporated, by reference, in other standards.***

### 3.6.1 Goal and Objectives

#### Goal

Facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications. Provide technical resources to harmonize the development of international standards among the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO), and the Global Regulation on Pollution and Energy (GRPE) Program.

### Objectives

- Complete the drafting of hydrogen building codes for the National Fire Protection Association's (NFPA's) hearing cycle.
- By 2005, facilitate the adoption of the International Code Council (ICC) codes in three key regions: Northeast, Mid-Atlantic, and Midwest.
- By 2006, support and facilitate the completion and adoption of the ISO standards for hydrogen refueling and storage.
- By 2008, support and facilitate the completion and adoption of the revised NFPA 55 standard for hydrogen storage with data from Technology Validation program element activities and the experimental project for underground bulk storage of hydrogen.
- By 2010, support and facilitate U.S. adoption of a Global Technical Regulation (GTR) for hydrogen fuel cell vehicles under the United Nations Economic Commission for Europe World Forum for Harmonization of Vehicle Regulations Working Party on Pollution and Energy under the GRPE program (ECE-WP29/GRPE).

## 3.6.2 Technical Approach

The Hydrogen, Fuel Cells & Infrastructure Technologies Program is addressing domestic and international codes and standard issues. The program recognizes that affordable hydrogen and fuel cell technologies must be developed and domestic and international codes and standards must be established simultaneously to enable the timely commercialization and safe use of hydrogen technologies.

Numerous reports and investigations have determined that the lack of codes and standards that are applicable to hydrogen as an energy carrier is a major institutional barrier to deploying hydrogen technologies and developing a hydrogen economy, and that it is in the national interest of the U.S. to eliminate this potential barrier. As such, this program is working with domestic and international Standard Development Organizations (SDOs) to identify and facilitate the development of equipment standards for design, safety, and performance testing, which can be referenced by building codes to help expedite approval of hydrogen technologies by regulatory authorities, and thus facilitate their commercialization. Many countries are pursuing the development and commercialization of hydrogen technologies and this approach will ensure that U.S. developers can market their products anywhere in the world. It will also ensure that U.S. consumers can purchase products that are safe and reliable, regardless of their country of origin.

Currently thirteen U.S. and two international SDOs are developing and publishing the majority of the voluntary domestic codes and standards (See Table 3.6.1). These organizations typically work with the public and private sectors to craft standards. In the U.S., the American National Standards Institute (ANSI) coordinates standards development, provides guidance on consensus building, recommends that no more than one standard is developed per technology, and acts as a central point of contact for the harmonization of international standards.

## Domestic Codes and Standards Development

In the development of hydrogen codes and standards, the Hydrogen, Fuel Cells & Infrastructure Technologies Program acts as a facilitator to accelerate the identification of gaps in the standards development process and provides funding to address these gaps. The Hydrogen, Fuel Cells & Infrastructure Technologies Program is also assuming a communication and education role, so that timely, accurate, and relevant information is prepared and disseminated to stakeholders.

Table 3.6.2 summarizes the various roles that the private sector and federal government have in the development process. The federal government's traditional role has been to serve as a developer for standards that cover technologies or applications that are of national interest. Examples include the involvement of the U.S. Coast Guard in standards for marine use; the Department of Transportation (DOT) for tunnels, railroads and interstate highways; and DOE for appliances ("Energy Star"). In each case, the private sector played a significant role in the process.

The federal government also plays an important role in the adoption process, which involves converting a voluntary standard or model code into a mandatory law or regulation. Congress has the power to pass laws governing both residential and commercial building design and construction to ensure public safety, although it rarely takes these steps. The regulatory branch of the federal government (DOT, DOE, Department of Housing and Urban Development, and the Environmental Protection Agency (EPA)) may also be granted authority by Congress to adopt and implement regulatory programs. Usually these government agencies rely on the private sector to ensure consensus. Generally, these agencies develop their own criteria only when these voluntary processes are slow to act, when the technology is not widespread, or when additional criteria are needed by the federal government.

**Table 3.6.1 Organizations Involved in Codes and Standards Development and Publication**

| Organization | Responsibility |
|---|---|
| **Domestic Codes and Standards** | |
| American Society for Testing and Materials (ASTM) | Materials testing standards |
| American National Standards Institute (ANSI) | Organization specifying the methodology of codes and standards development |
| American Petroleum Institute (API) | Equipment standards |
| American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) | Equipment design and performance standards |
| American Society of Mechanical Engineers (ASME) | Equipment design and performance standards |
| Compressed Gas Association (CGA) | Equipment design and performance standards |

| | |
|---|---|
| Canadian Standards Association (CSA) International of America | Equipment standards |
| International Association of Plumbing and Mechanical Officials (IAPMO) | Mechanical building code |
| Institute of Electrical and Electronic Engineers (IEEE) | Electrical standards |
| International Code Council, Inc. (ICC) | Family of model building codes |
| National Fire Protection Association (NFPA) | Model building codes, standards |
| Natural Gas Institute (NGI) | Natural gas vehicle standards |
| Society of Automotive Engineers (SAE) | Vehicle standards |
| Underwriters Laboratories (UL) | Equipment and performance testing standards |
| **International Codes and Standards** | |
| International Electrotechnical Commission (IEC) | International performance standards |
| International Organization for Standardization (ISO) | International performance standards |

**Table 3.6.2. Private and Federal Sector Role in Codes and Standards Development**

| Private Sector | | Government Sector | | |
|---|---|---|---|---|
| Standard Development Organizations | Other Private Sector Firms | Federal | State | Local |
| Develop consensus-based codes and standards with open participation of industry and other stakeholders | Develop hydrogen technologies and work with SDOs to develop standards | Facilitate the development of codes and standards, support necessary research and other safety investigations,and communicate relevant information to stakeholders (including state and local government agencies) | Evaluate the codes and standards that have been developed and decide whether to adopt in whole, part, or with changes. | Evaluate consensus-based codes and standards that have been developed and decide whether to adopt in whole, part, or with changes. |

## International Codes and Standards Development

The Hydrogen, Fuel Cells & Infrastructure Technologies Program is pursuing the development of international codes and standards to promote trade between the U.S. and other countries. The program provides support to technical experts' attendance and participation in support of

U.S. concerns at key international codes and standards development organization meetings, sponsored by ISO, IEC, and ECE-WP29/GRPE.

The U.S. strives to reach consensus positions on national standards, which it then positions internationally. Occasionally, the U.S. participates in developing an international standard for which no U.S. consensus position has been established. In that case, the body representing U.S. interests (typically ANSI) ensures broad, cross-cutting participation from U.S. companies and organizations in the international activity.

Currently there are some concerns that draft regulations for gaseous hydrogen developed by the GRPE could become ECE regulations and eventually GTRs. In Europe, ECE regulations are legal requirements. This could potentially accelerate the development of European hydrogen-related technologies and provide a competitive advantage to European car manufacturers in the commercialization of the technologies. This could certainly be the case if the GRPE draft regulations do not cite ISO standards. Currently, it is unclear how the ISO standards, once completed, will be incorporated into the ECE regulations. The Codes and Standards program element is carefully monitoring this situation.

## 3.6.3 Programmatic Status

### Current Activities

The Current Hydrogen Codes and Standards program element activities are summarized in Table 3.6.3.

**Table 3.6.3. Ongoing Activities for Hydrogen Codes and Standards**

| Activity | Objective |
|---|---|
| **U.S. Domestic Codes and Standards Development Activities** | |
| Stakeholder Meetings and Technical Forums | Supports technical and coordination meetings to ensure communications among key stakeholders. |
| Technical Expertise | Supports hydrogen safety research and provides expert technical representation at key industry forums and codes and standards development meetings. |
| Consensus Codes and Standards Development | Develops national template fro codes and standards and information dissemination to the 2003 ICC Family of Codes Revision process. |
| Information Dissemination | Supported the development of a hydrogen energy technology module as part of the DER “Road Show”. Also supports information forums for local chapters of building and fire code officials, and the development of a case study on the permitting of hydrogen refueling stations. |
| Research, Testing, and Certification | Supports focused research and testing services needed to verify the technical basis for hydrogen codes and standards and for certification of components and equipment. |

| | |
|---|---|
| Training Modules and Informational Videos | Supports the development of mixed media training modules and informational videos for local code officials, fire marshals, and other fire and safety professionals. |
| National Template for Standards, Codes, and Regulations | Identifies key areas of standards,codes, and regulations for hydrogen vehicles and hydrogen fueling/service/parking facilities and designates lead and supporting organizations. |
| Codes and Standards Matrix Database | Provides inventory and tracking of relevant domestic codes and standards: identifies gaps, minimizes overlap, and ensures that a complete set of necessary standards is written. |
| **U.S. International Codes and Standards Development Activities** | |
| International Stakeholder, Consensus Development, and Harmonization Meetings | Supports the international codes and standards development activities of National Hydrogen Association (NHA) and Partnership for Advancing the Transition to Hydrogen (PATH). PATH is a collaboration of the national hydrogen associations of Canada, Japan, U.S., and potentially, other key Pacific Rim nations. |
| Technical Expertise and Underlying Research Activities | Provides representation and technical expertise in support of U.S. concerns at key international codes and standards development organization meetings and forums, including ISO, IEC, and United Nations Economic Commission for Europe (WP29/GRPE). |

## Status of Equipment Standards

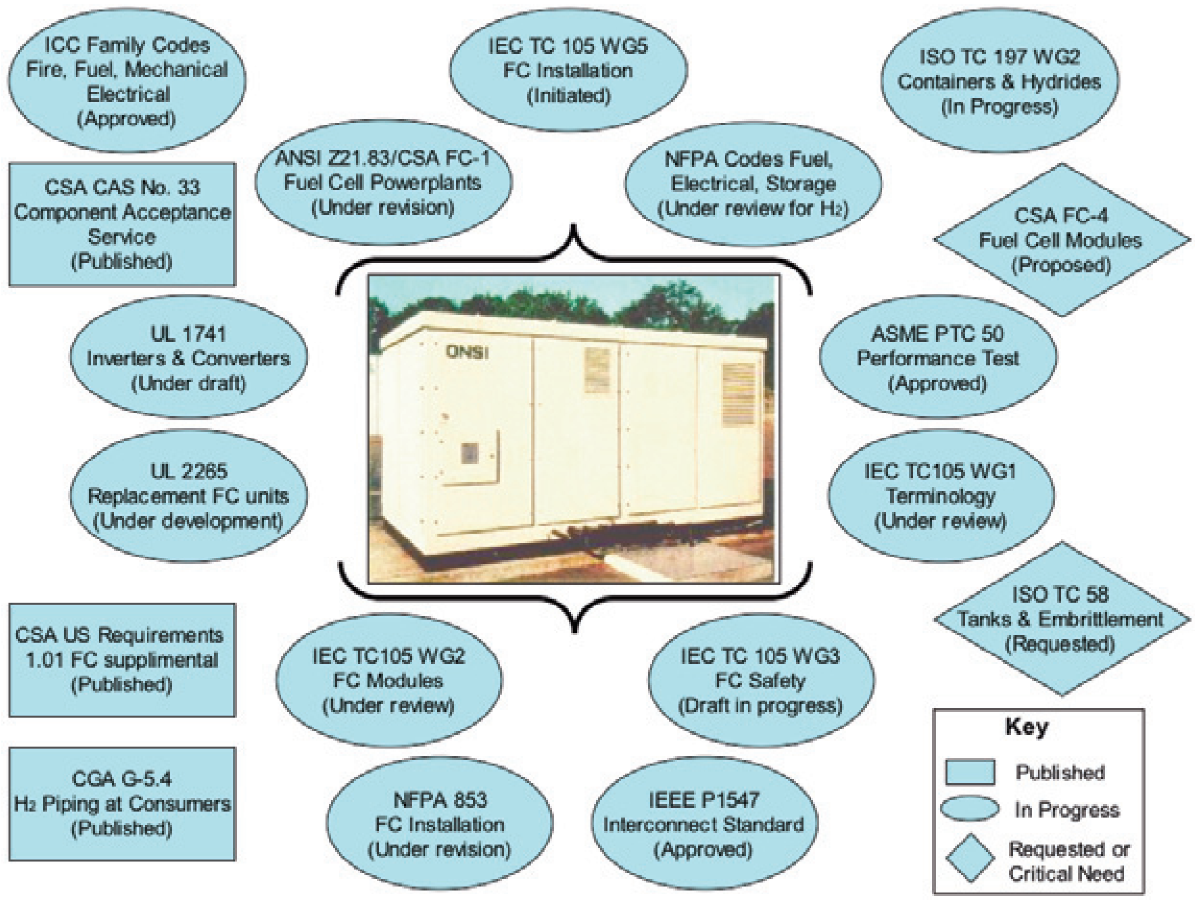
### Domestic Standards

Organizations that are developing standards for fuel cell power plants, vehicles, related equipment, and installation of the infrastructure are the American Society of Mechanical Engineers (ASME), National Fire Protection Association (NFPA), Underwriters Laboratory (UL), Compressed Gas Association (CGA), Canadian Standards Association International of America (CSA), Society of Automotive Engineers (SAE), and the Institute of Electrical and Electronics Engineers (IEEE).

## Stationary Fuel Cell Standards

Stationary fuel cell standards are the most comprehensive, as the phosphoric acid fuel cell has been commercially available for more than 20 years. Published in 1998 by CSA as ANSI Z21.83, this standard applies to packaged, self-contained, factory-assembled power plants for use with natural gas, propane, and landfill gas, with an output of at least 1000 kW. This standard is being revised to more adequately represent all fuel cells. Figure 3.6.1 illustrates the significant efforts underway for standards development related to stationary fuel cells.

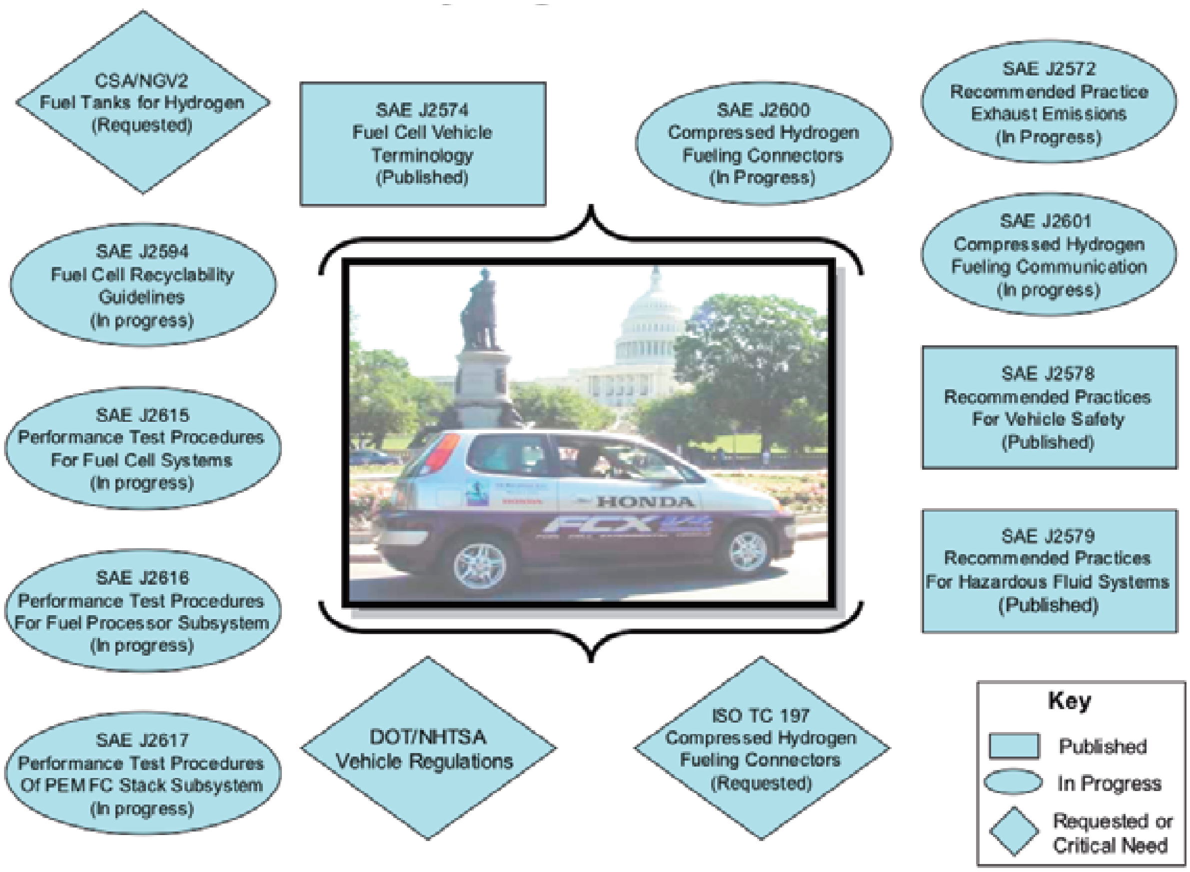
Figure 3.6.1. Stationary Fuel Cell Standards



## Fuel Cell Vehicle Standards

The second most comprehensive effort is the development of standards for automotive technologies. SAE, working with technical experts from automotive, industrial gas, and fuel cell companies, has developed a list of the standards that are needed for the commercialization of fuel cell vehicles. Figure 3.4.2 shows the standards under development for fuel cell vehicle applications.

Figure 3.6.2. Fuel Cell Vehicle Standards

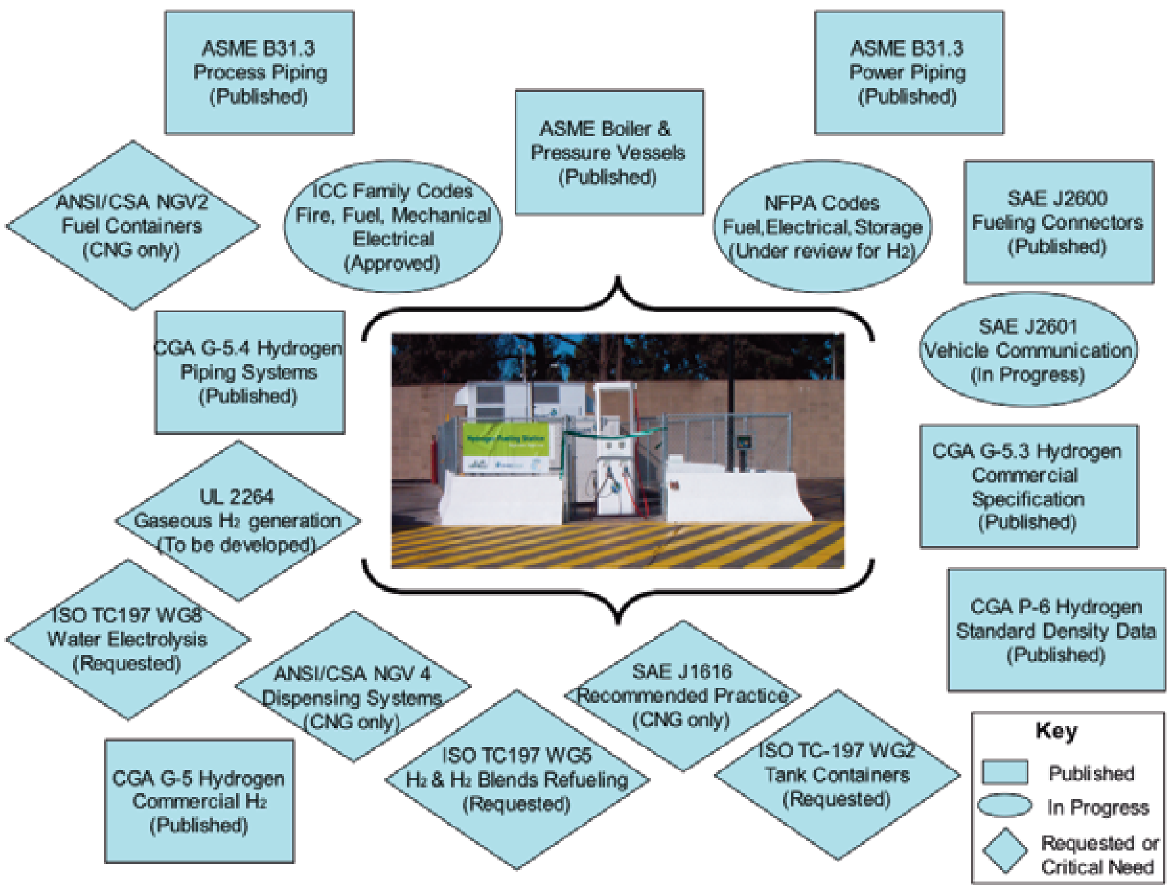


## Refueling Station Standards

The development of standards for hydrogen fueling stations lagged all other efforts, until efforts were redoubled in 2000. Although standards have been developed for commercial production, delivery, and use of hydrogen, these industry-based design requirements and standard operating procedures are not suitable for dealing with hydrogen in a nonindustry environment.

If industry practices were applied to use of hydrogen as a vehicle fuel, safety keep-out zones for bulk storage would dominate the land and cost requirements for refueling stations. Efforts were focused on developing new standards, or clarifying the language or constraints in established standards. Figure 3.4.3 shows the standards development efforts for fueling station. In all cases, safety is ensured through comprehensive engineering reviews, hazard evaluations, and risk mitigation plans.

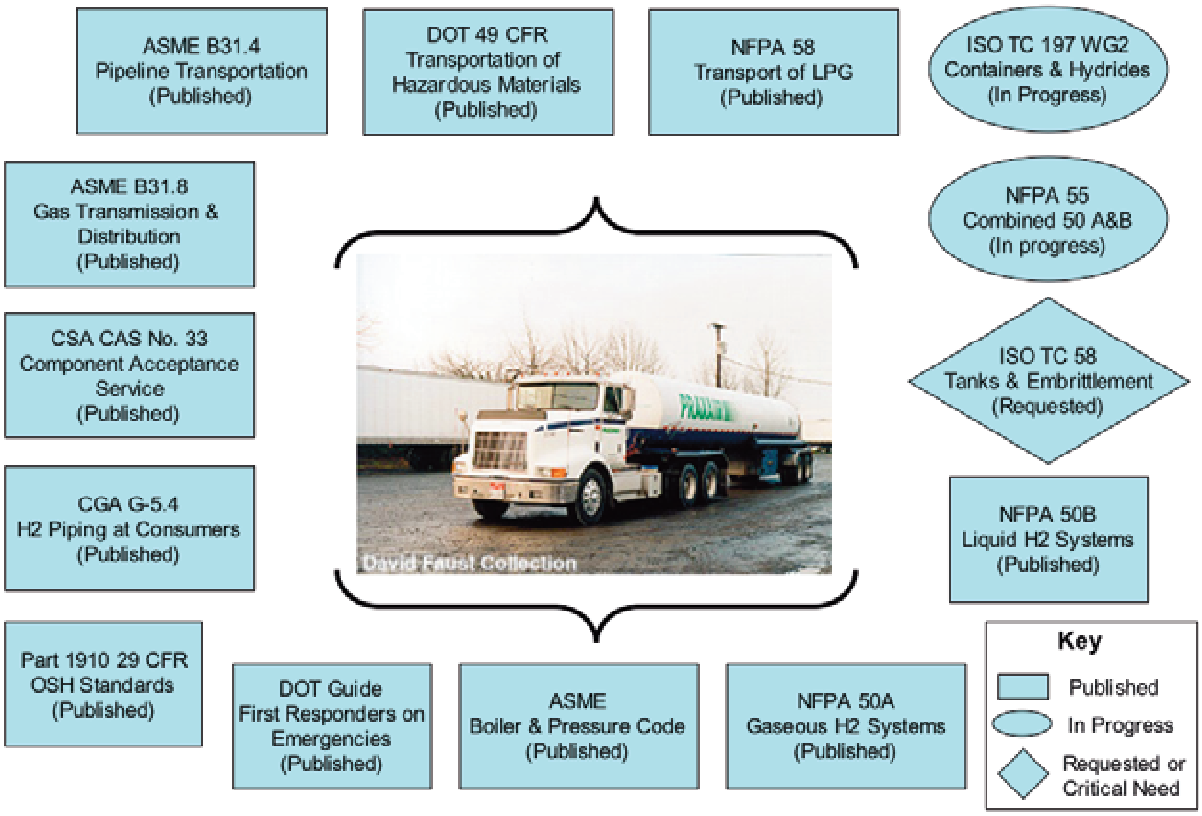
**Figure 3.6.3. Refueling Stations Standards**



## Hydrogen Transportation Standards

Since the 1950's, hydrogen has been transported across the U.S. using a federal code of regulations for the safe transport of hydrogen in bulk and small portable containers developed by DOT. An effort is underway to update these standards to address the range of technologies now available. Figure 3.4.4 illustrates the status of standards for the transport of hydrogen.

**Figure 3.6.4. Hydrogen Transportation Standards**




## International Standards

Three separate but related international efforts are underway to develop new technology standards: the International Organization of Standardization (ISO), the International Electrotechnical Commission (IEC), and the World Forum for Harmonization of Vehicle Regulations.

**International Organization of Standardization.** The ISO is a worldwide federation of national standards bodies from more than 140 countries. Established in 1947, its mission is to promote standardization to facilitate the exchange of goods and services, and to facilitate cooperation in intellectual, scientific, technological, and economic activities. ISO standards are developed through a consensus process. They are global solutions to satisfy industries and

customers and are based on voluntary involvement of interested parties.
The process by which a standard is developed by ISO is outlined below:

- The need for an international standard is expressed by an industry sector, which communicates this need to a national member body.
- The national member proposes the new work item or items to ISO as a body.
- Once recognized by ISO, a formal approval process by the main body and the phases of development are undertaken:
  - o Definition: The technical scope of the future standard is identified and defined by working groups of experts from interested countries.
  - o Consensus: Countries negotiate the detailed specifications within the standard.
  - o Approval: The acceptance by two-thirds of the ISO members that have participated in the standards process, and approved by 75% of all members that vote.

To date, ISO's work has resulted in more than 12,000 international standards. The following ISO Technical Committees are working on standards related to hydrogen and fuel cells:

- **TC 22 - Road Vehicles:** compatibility, interchangeability, and safety, with particular attention to terminology and test procedures for mopeds, motorcycles, motor vehicles, trailers, semi-trailers, light trailers, combination vehicles, and articulated vehicles. The Electric Road Vehicle Subcommittee is addressing operation of the vehicles, safety, and energy storage. France chairs the Technical Committee and Germany chairs the Subcommittee.

- **TC 197 - Hydrogen Technologies:** systems and devices for the production, storage, transport, measurement, and use of hydrogen. Ten working groups are focusing on fuel tanks, multimodal transport of liquid hydrogen, airport refueling facility, hydrogen safety, hydrogen and hydrogen blends, water electrolysis, fuel processing, and transportable gas storage devices.

- **TC 58 - Gas Cylinders:** fittings and characteristics related to the use and manufacture of high-pressure gas storage. One working group on gas compatibility and materials coordinates with TC 197.

## International Electrochemical Commission

The IEC is the leading global organization for preparing and publishing international standards for all electrical, electronic, and related technologies. Its charter includes all electrotechnologies including electronics, magnetics and electromagnetics, electroacoustics, multimedia, telecommunication, and energy production and distribution as well as general disciplines such as measurement and performance, dependability, design and development, safety, and the environment.

The IEC is developing standards for the electrical interface to fuel cells. IEC Technical Committee 105 is primarily addressing stationary fuel cell power plants, but has also addressed portable and propulsion fuel cells. There are seven working groups in TC 105: Terminology, Fuel Cell Modules, Stationary Safety, Performance, Installation, Propulsion, and Safety and Performance of Portable Fuel Cells. ANSI coordinates the U.S. position on ISO and IEC standards.

### World Forum for Harmonization of Vehicle Regulations

Within the U.N. framework on GRPE, the European Union recognized a need to harmonize vehicle regulations. The original agreement was signed in 1958, with contracting parties including most European countries, Australia, Japan, and South Africa. Standards developed under the 1958 agreement are presented to the contracting parties, which have two years to adopt them as national standards. Legal requirements ("regulations" or "directives") under this agreement are based on the "type" approval process, wherein an authority works with a technical service to assess compliance of components and systems (such as a vehicle). European countries use the "type" approval process, where the U.S. uses a self-certification process.

Since the initial agreement, the ECE WP29 developed a new "accelerated" agreement to allow the development of global legal requirements. The 1998 agreement has most European countries, Canada, China, Japan, Korea, South Africa, and the U.S. as contracting parties. This new concept is termed Global Technical Regulations (GTR). These regulations are essentially technical requirements; therefore, they allow the use of different approval processes and global harmonization of legal requirements for all vehicles.

In 2001, the European Integrated Hydrogen Project (EIHP), a 10-partner project to help develop and commercialize hydrogen vehicles, was created to address the issues of codes, standards, and legal requirements. Different technical solutions are usually required across Europe to address the legal requirements established by various countries. Legal requirements are binding and are much slower to develop and adopt. Without legal requirements in Europe for the approval of hydrogen and fuel cell components and vehicles, the time and cost to register a vehicle for use are prohibitive. Therefore, the EIHP has undertaken the drafting of new ECE regulations to be presented to WP 29 to accelerate the process.

As a result, the GRPE established an Ad Hoc Group under German leadership to draft regulations for gaseous and liquid hydrogen systems. The ISO process and that instituted by the GRPE will harmonize the differences between both standards. In June 2002, the GRPE voted to move all actions for the introduction of fuel cell vehicles under the 1998 agreement to accelerate the development and adoption of a GTR.

## 3.6.4 Challenges

The fundamental challenge to the commercialization of hydrogen technologies is the availability of the appropriate codes and standards to ensure uniformity and facilitate deployment. Standards are required to allow appropriate certification and testing to assure local code officials and safety inspectors that sufficient safety standards have been met. Uniform standards are required because manufacturers cannot cost-effectively manufacture multiple products that would be required to meet different and inconsistent standards.

Domestically, the competition between the individual SDOs could impact the adoption of new codes for hydrogen and fuel cell technologies. For example, the competition between the NFPA and ICC will certainly affect the adoption of new model codes for these technologies. Because of the 3–5 year code development cycle employed by SDOs, some potential demonstration projects could be delayed or incur additional development costs. One example of this would be in

California, which recently adopted the NFPA codes over the ICC codes, although ICC codes have recently included hydrogen into its model building codes.

International standards developed by ISO and IEC will have an increasing impact on U.S. fuel cell interests, especially in portable and propulsion applications. The U.S. appears to be leading the development of fuel cell-related standards, but Japan and Germany have accelerated their efforts in this area. There is increasing pressure for acceptance and reliance on the development of international standards, a position supported by DOE.

As participation in the codes and standards process increases, disagreement about who is responsible for fuel cell vehicle standards has intensified. The IEC has an approved work program that includes standards for the fuel cell module. Other standards committees within the ISO are responsible for road vehicles, hydrogen, and the interface between vehicle and dispenser. Competition, duplication, and conflict must be addressed.

The SAE is assuming more autonomy in the development of standards for vehicular applications. As a national organization, its principal interests should lie with the U.S. industry to accelerate the development and adoption of national standards; however, SAE believes that most of its efforts should be focused on the development of international standards. This has led to some conflict between the various parties because it appears that the U.S. auto companies are not supporting the national agenda, as they have not provided technical experts for new working committees.

Perhaps a more serious challenge is the lack of available data necessary to develop and validate standards. This is due to a number of factors, including concerns about proprietary or competition-sensitive information, rapid technology development, and declining investment income and industry consolidation.

### 3.6.4.1 Targets

Since it is a voluntary, industry-led process, the federal government can influence but cannot direct the development of the model codes or domestic and international standards. The Codes and Standards program element activities will focus on assisting the commercial acceptance of hydrogen and fuel cell technologies.

By working work with states and local code officials, the Hydrogen, Fuel Cells & Infrastructure Technologies Program will help develop training programs that will: 1) explain the new technologies, 2) provide case studies of installations and operation, and 3) communicate the changes in the codes as they pertains to the new technology. It will also work with state and local government officials to assist in the adoption of the approved model codes by conducting workshops and road shows to explain the status of the code process.

Through activities with NFPA and the ICC, the Hydrogen, Fuel Cells & Infrastructure Technologies Program will provide experts and technical data on hydrogen and fuel cell technologies and will facilitate the development of amended model codes for inclusion in their respective family of codes, see Table 3.6.4. Additionally, the program will provide support for industry and laboratory experts to attend and participate in critical international standards development meetings and workshops.

**Table 3.6.4. Family of Model Codes**

| Model Code | Content |
|---|---|
| Fire Code | Regulations affecting or relating to structures, processes, premises, and safeguards regarding fire and explosions. |
| Building Code | Ensures public health, safety, and welfare as they are affected by repair, alteration, change of occupancy, addition, and location of existing buildings. |
| Electrical Code | Ensures public safety, health, and general welfare through proper electrical installation, including alterations, repairs, replacement, equipment, appliances, fixtures, and appurtenances. |
| Property Maintenance Code | Ensures adequate safety and health as they are affected by existing building structures and premises. |
| Zoning Code | Enforces land use restrictions and implements land use plan. |
| Energy Conservation Code | Ensures adequate practices for appliances, HVAC, insulation, and windows for low cost operation. |
| Residential Code | Applies to the construction, alteration, movement, enlargement, replacement, repair, use, and occupancy of one- and two-family dwellings. |
| Plumbing Code | Regulates the erection, installation, alternation, repairs, relocation, and replacement, in addition to use or maintenance, of plumbing systems. |
| Mechanical Code | Regulates the design, installation, maintenance, alteration, and inspection of mechanical systems that are permanently installed and used to control environmental conditions and related processes. |
| Fuel Gas Code | Regulates the design, installation, maintenance, alteration, and inspection of fuel gas piping systems, fuel gas utilization equipment, and related accessories. |
| Performance Code | Establishes requirements to provide acceptable levels of safety for fire fighters. |

The Program will continue to work directly with the SDOs, by providing supporting technical and coordination meetings to facilitate an accelerated identification and development of new standards for hydrogen storage and production systems; fuel cell performance, maintenance, and reliability; and system monitoring and safety.  Table 3.6.5 lists the standards that the SDOs have identified as being required. Finalize a licensing agreement with the SDOs to allow the government to distribute published codes and standards to jurisdictions for the adoption process.

**Table 3.6.5. High Priority Standards for Development**

| Standard | Content |
|---|---|
| Piping | Hydrogen-specific piping design, installation, training, and certification. Replaces B31.3 reference in ICC Family of Codes. |
| Storage | Hydrogen storage tank for portable and stationary service. Standard will be independent of adsorbent. New standard for vehicular transport of high-pressure hydrogen to pressures of 10,000 psi. Includes supporting R&D program funded by DOE. |
| Materials Guide | Ensures public safety, health, and general welfare through proper selection of materials for hydrogen service. Reference for existing design and installation standards. |
| Hydrogen Quality | Ensures safety by defining testing methods to determine the quality of the fuel independent of production technique. |
| Mass Flow Measurement | Defines methods to quantify hydrogen mass flow rate to determine appliance efficiency. |
| Transport | Reviews and modifies existing piping standards and underground storage. |

Finally, the Hydrogen, Fuel Cells & Infrastructure Technologies Program will continue to support focused research, testing, and certification for hydrogen components and equipment. An R&D plan will be developed to lay out the requirements for these activities and obtain industry acceptance as needed to provide critical technical and performance data for hydrogen and fuel cell systems.

***One critical item that will be addressed through these activities will be the issue of setback distances associated with NFPA 55. Current setback distances for hydrogen storage facilities would make it difficult to place hydrogen refueling stations near roadways. Reduced footprints, which are accomplished by smaller separation distances, are important to commercialization efforts. The resulting technical data will be incorporated into the codes and standards development process.***

The targets for this program element are summarized in Table 3.6.6.

**Table 3.6.6 Targets for Hydrogen Codes and Standards**

1) Establish a comprehensive training program for code officials and fire marshals. (Objective 1, Task 1)
2) Adopt model building code. (Objective 1, Task 2)
3) Negotiate DOE licenses for critical standards and model codes. (Objective 1, Task 7)
4) Publish ISO standards. (Objective 2, Task 3)
5) Complete and sign memorandum. (Objective 2, Task 4)
6) Secure initial license for ISO standards. (Objective 2, Task 5)
7) Incorporate new analysis and data into revised standard. (Objective 2, Task 6)
8) Implement research program for underground hydrogen storage. (Objective 3, Task
9) Agrees in principle, as a nation, to adopt a global technical regulation for hydrogen fuel cell vehicles under GRPE. (Objective 4, Task 9)

## 3.6.4.2 Barriers

The barriers are summarized below.

**A. Limited Government Influence on Model Codes.** The code development process is voluntary, so the government can affect its progression, but buy-in is ultimately required from code publishing groups.

**B. Competition between ICC and NFPA.** The competition between the ICC and the NFPA, stemming from a number of failed attempts to develop a single fire code, will complicate the creation of consistent hydrogen building codes.

**C. Limited State Funds for New Codes.** Budgetary shortfalls in many states are having a large impact on the adoption of codes and standards, since local jurisdictions do not have the funds for purchasing new codes or for training building and fire officials.

**D. Large Number of Local Government Jurisdictions (approximately 44,000).** Ultimately it is the responsibility of local government jurisdictions to adopt model codes, but budgetary shortfalls in many states and communities will have having a large impact on the adoption of codes and standards, since local jurisdictions do not have the funds for purchasing new codes or for training building and fire officials.

**E. Officials Training Differences**. The training of code officials is not mandated and varies significantly. .

**F. Limited DOE Role in the Development of ISO Standards.** Governments can participate and influence the development of codes and standards, but they cannot direct the development of ISO standards.

**G. Inadequate Representation by Government and Industry at International Forums.** It is expensive to provide adequate representation at international forums and meetings. As a result, there are also difficulties in promoting the findings of international technical committees to domestic industry experts.

H. **International Competitiveness.** International code development is usually complicated and difficult to achieve because of international competitiveness and licensing issues.

I. **Strategic Conflicts between Domestic and International Standards Objectives.** National agendas often create conflicts about the most appropriate domestic and international standards.

J. **Consensus National Agenda on Codes and Standards.** Competitive strategic issues must be overcome in reaching consensus.

K. **Lack of Domestic Industry Support at International Technical Committees**. Domestic hydrogen experts are needed to support the activities conducted within the international technical committees. A great deal of U.S. expertise is employed in small businesses, academia, and government agencies, and the costs and participation requirements are prohibitive.

L. **Competitiveness in Copyright of Published Standards.** The development and licensing of codes and standards is "big" business, and the competitiveness associated with the adoption of one set of codes and standards versus another is usually quite fierce.

M. **MNFPA 55 has not yet been completed, but is currently in progress.** NFPA codes are accepted by some states and local jurisdictions; others accept ICC codes. Currently, only the ICC families of codes address the use of hydrogen in the built environment. Jurisdictions that adhere to NFPA codes cannot reference codes that address the use of hydrogen technologies.

N. **Lack of Technical Data to Revise NFPA 55 Standard (for underground and aboveground storage).** Research activities are underway to develop and verify the technical data needed to support codes and standards development, but it is not yet completed. A sustained effort may be required.

O. **Insurance Companies Recognize Current Standards. Insurance rates are tied to codes and standards.** New technologies not yet recognized in codes and standards will have difficulty in obtaining reasonable insurance, and may not be approved in some cases.

P. **Current Large Footprint Requirements for Hydrogen Fueling Stations.** The set back and other safety requirements in effect for the use of hydrogen in industrial applications result in excessively large footprints. There is a need to review all the existing technical data and conduct research, testing, and analysis to ensure that public safety needs are addressed, but that the safety requirements are not so excessive as to prohibit commercialization.

### 3.6.5 Task Descriptions

Task descriptions for the Hydrogen Codes and Standards program element are presented in Table 3.6.7. To complete these tasks, this program element will collect and analyze data from the Production, Delivery, Storage, Fuel Cells, and Technology Validation subprograms on an on-going basis.

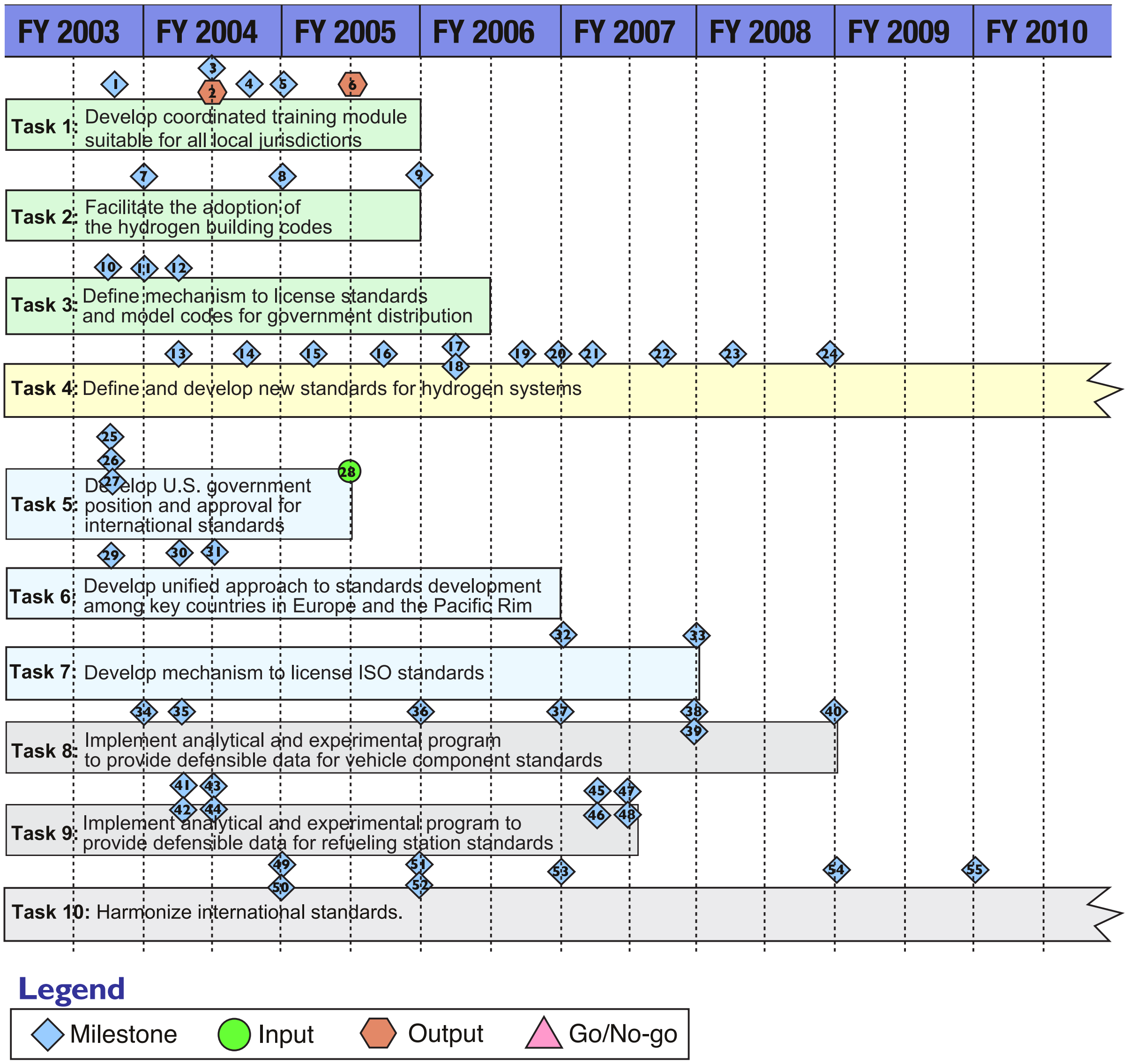
| | Table 4.6.7. Task Descriptions | |
|---|---|---|
| | Description | Duration/Barriers |
| 1 | Develop coordinated training module suitable for all local jurisdictions | 10 Quarters/Barriers C, D, E |
| 2 | Facilitate the adoption of the hydrogen building codes | 12 Quarters/Barriers C, D |
| 3 | Define mechanism to license standards and model codes for government distribution | 5 Quarters/Barriers A, B |
| 4 | Define and develop new standards for hydrogen systems | 24 Quarters/Barriers O |
| 5 | Develop U.S. government position and approval for international standards | 10 Quarters/Barriers F, G |
| 6 | Develop unified approach to standards development among key countries in Europe and the Pacific Rim | 5 Quarters/Barriers H, I, J |
| 7 | Develop mechanism to license ISO standards | 20 Quarters/Barrier L |
| 8 | Implement analytical and experimental program to provide defensible data for vehicle component standards | 24 Quarters/Barriers M, N, O, P |
| 9 | Implement analytical and experimental program to provide defensible data for refueling station standards | 18 Quarters/Barriers M, N, O, P |
| 10 | Harmonize international standards | 28 Quarters/Barriers H, I, J |

Note: The total duration of the program planning period is 32 quarters; tasks that begin before this period or continue beyond it do not reflect durations outside the planning period.

## 3.6.6 Milestones

Figure 3.6.5 shows the interrelationship of  milestones, tasks, supporting inputs from other programs and outputs for the Hydrogen Production program element from FY 2004 through FY 2010. This information is also summarized in Table B.6 in Appendix B.

Figure 3.6.5. Hydrogen Codes and Standards R&D Network




For chart details see next page.

1. Produce a curriculum for training modules.
2. Output to Education: Training modules for current practices
3. Collaborate with ICC and NFPA to develop first- order continuing education for code officials.
4. Establish a coordination plan with education sub program to run workshops for state and local officials.
5. Establish schedule of training for state and local officials.
6. Output to Education: Training modules for amended practices for new technologies
7. Develop a mechanism for hydrogen technical experts to support the code development process.
8. In conjunction with model code developers, draft approach to provide analytical and experimental support for code changes.
9. Execute analytical experiments and collect data as needed to support code development.
10. Produce gap analysis for critical standards and determine which standards development organizations (SDOs) should lead efforts.
11. Initiate negotiations with critical SDOs and develop draft generic licensing agreement and estimate of costs.
12. Prepare final generic licensing agreement, schedule of critical licensing agreements, and budget requirements for FY04.

13. Draft standards for transportable containers
14. Draft standards for refueling stations
15. Draft standards for vehicles
16. Draft standards for stationary power
17. Draft standards for the integration of sensors and leak detection equipment
18. Finalize standards for transportable containers
19. Finalize standards for refueling stations
20. Draft standards for portable fuel cells
21. Finalize standards for vehicles
22. Finalize standards for stationary power
23. Finalize standards for the integration of sensors and leak detection equipment
24. Finalize standards for portable fuel cells

25. Negotiate agreement with DOT/NHTSA at Working Party on Pollution and Energy meeting.
26. Assemble a team of technical experts to support international standards development process.
27. Develop a mechanism to support appropriate U.S. Technical Advisory Groups (TAG).
28. Inputs from all program elements: Technology Assessments
29. Identify areas of joint agreement between EIHP and PATH.
30. Initiate the development of the next generation Sourcebook to include Japan, Europe, Canada & U.S.
31. Review and negotiate terms and conditions with necessary parties.
32. Negotiate terms and conditions for licensing ISO standards.
33. Obtain general licensing agreement.

34. Convene workshop to identify and develop critical research objectives that limit or impact model codes.
35. Produce a research plan including schedule and budget
36. Develop standards for connector interface
37. Develop standards for on-board storage
38. Develop standards for fuel dispensing
39. Develop standards for crash worthiness (substation)
40. Finalize standards for crash worthiness (vehicle)
41. With industry and code officials, develop templates of commercially viable footprints for fueling stations that incorporate underground and aboveground storage of liquid and gaseous hydrogen.
42. Circulate research plan to stakeholders and incorporate comments.
43. Publish the Phase 1 research plan.
44. Issue solicitation for work required in the Phase 1 research plan.
45. Develop templates of commercially viable footprints for fueling stations that incorporate advanced technologies
46. Circulate research plan to stakeholders and incorporate comments.
47. Publish the Phase 2 research plan.
48. Issue solicitation for work required in the Phase 2 research plan.
49. Complete the harmonized regulation for hydrogen storage.
50. Complete the technical draft for vehicular safety standards.
51. Implement analytical and experimental program to support the submittal of a comprehensive vehicular safety standard as a regulation
52. Complete standards for fuel cell power plants, for performance verification of efficiency and emissions.
53. Implement research program to support five new technical committees for the key critical standards including fueling interface, power block, and fuel storage.
54. Prepare a comprehensive draft regulation for a vehicle to be submitted as a GTR.
55. Draft regulation approval as a GTR.